Western Great Basin Seismic Network Operations

Cooperative Agreement

Award Number 04HQAG0004

Annual Project Summary

October 1, 2003-September 30, 2004

Budget Period: 12/01/2003 through 11/30/2004

Nevada Seismological Laboratory
University of Nevada Reno
P.I. Glenn Biasi

Summary

The Nevada Seismological Laboratory monitored seismicity in Nevada and eastern California, and developed earthquake information and hazard-related products for ANSS and the public. Over 8100 earthquakes were located in the monitoring area. Funding contributed to the support of 127 stations. One M 4.5 earthquake north of Lake Tahoe triggered a data-informed ShakeMap. Four new broad-band+strong motion stations were purchased for the Las Vegas Valley through a cooperation with Lawrence Livermore National Laboratory. Real-time data were shared with the IRIS DMC, four ANSS partners, and the Anza network. Triggered data are maintained at UNR for research and public access.

Activities Undertaken

Activities under Cooperative Agreement Award 04HQAG0004 were focused on maintaining and operating the Western Great Basin Seismic Network in Nevada. The Nevada Seismological Laboratory maintained 127 stations under this cooperative agreement. Among these 127 stations, six are dual weak- and strong-motion sites and forty are conventional stand-alone strong-motion recorders. Thirteen stations use three-component, 24-bit Reftek recorders. Nine use Teledyne-Geotech S-13 sensors, two have CMG-40 sensors, and two use CMG3-ESP's. Special monitoring stations around Yucca Mountain in southern Nevada are not included in these numbers.

The NSL produced approximately 8100 reviewed earthquake locations for the reporting

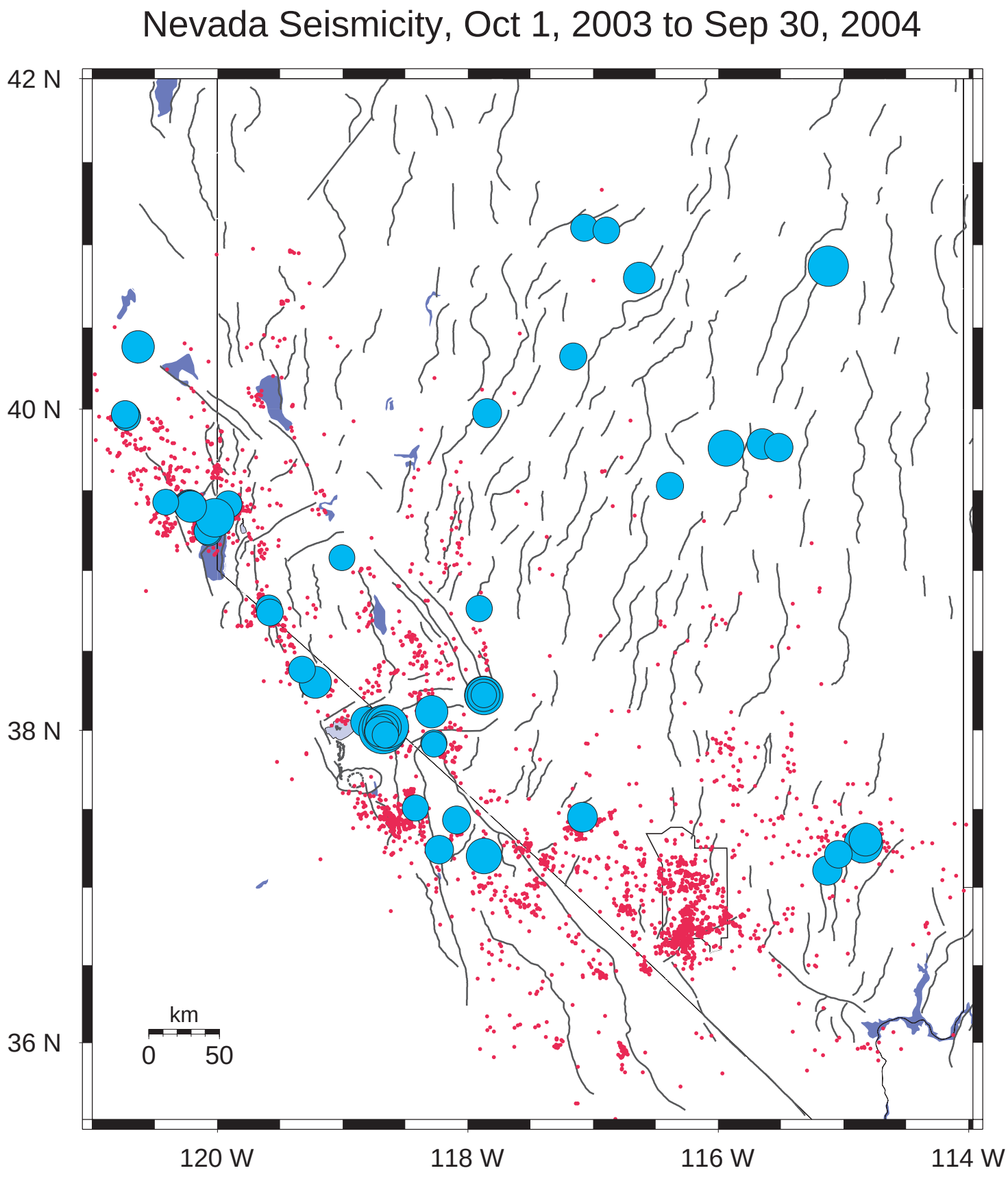


Figure 1. Seismicity for the combined Nevada networks for the period October 1, 2003 to September 30, 2004. Earthquakes with M >3.0 are shown as solid blue, scaled with magnitude. Red dots indicate smaller events.

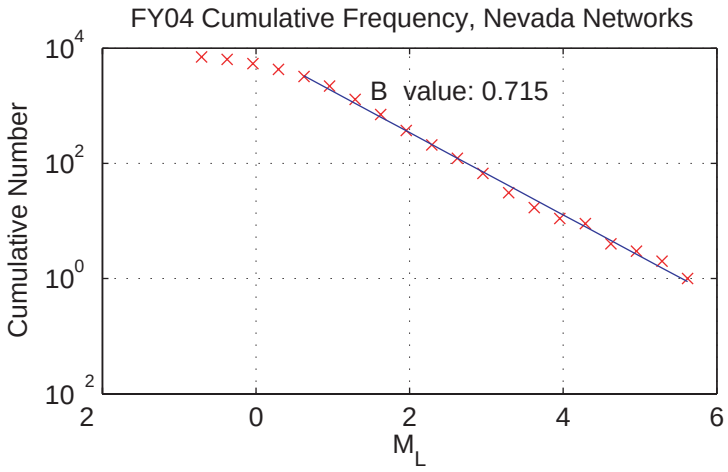


Figure 2. Magnitude-frequency distribution for Nevada seismicity from October 1, 2003 to September 30, 2004. Overall magnitude of completeness for earthquakes inferred from the roll-off at small magnitudes is near M 0.5 for the combined Nevada networks, and M 0.8 if Yucca Mountain area seismicity is removed. The b-value of 0.715 is relatively low for a large region.

period (Figure 1). Of these, approximately 6000 were more than 0.5 degrees from the Yucca Mountain region, and thus not located or analyzed as part of the special monitoring there. The median magnitude for the catalog is M_L 0.5. Figure 2 shows the network completeness threshold, based on the Gutenberg-Richter magnitude-frequency model, is approximately M 0.8. The b-value slope of 0.71 is somewhat low, but not unreasonable as a network average. Network completeness levels vary spatially within the network, from around M -0.3 to M 1.6 where seismicity permits GR completeness estimation. A consequence of the higher magnitude of completeness around the edges of the array is to dilute the number of the smaller events relative to the number of larger events for which detection is not an issue. Compared to the previous year, the number of M>3 events is somewhat higher, but similar to the long-term average.

The largest earthquake in the reporting period had a local magnitude of 5.62. It and an M 5.4 aftershock occurred on September 18, 2004, at 23:02 and 23:43 GMT, respectively. These events, with an active aftershock sequence (Figure 3), occurred on a east-northeast trending left-lateral strike-slip feature near the Adobe Hills east of Mono Lake and just inside California. This structure has been recognized as the southern right step in the active structures of the Walker Lane Belt. Throughout this sequence NSL continued to review events forwarded to QDDS and events on the web page within a day or less.

During the reporting period, strong-motion sensors were added to four permanent network stations. The sensors, Reftek RT131 MEMS accelerometer packages, were ordered in late FY 2003 and provided through ANSS program supplemental funding. These channels, recorded in triggered mode, provide high dynamic range coverage in the event that the weak-motion sensors clip. Five RT130-ANSS units were also installed in late calendar 2003 to complete backlogged strong-motion installations. Telemetry issues were resolved and real-time telemetry completed for several Las Vegas Valley stations, but some engineering remains to be done for two of the 2003 recorders. We are hopeful that revised software in the RT130-ANSS units will improve reliability through firewalls. To date this has been a significant cause for RT130 station down-time.

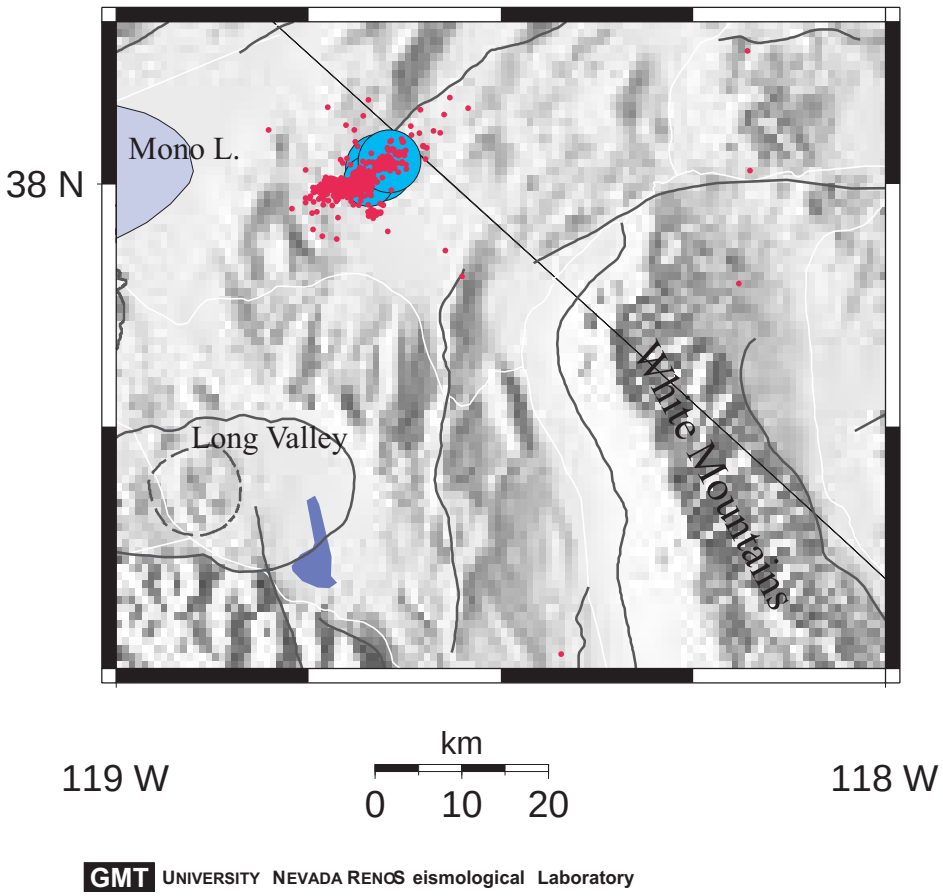
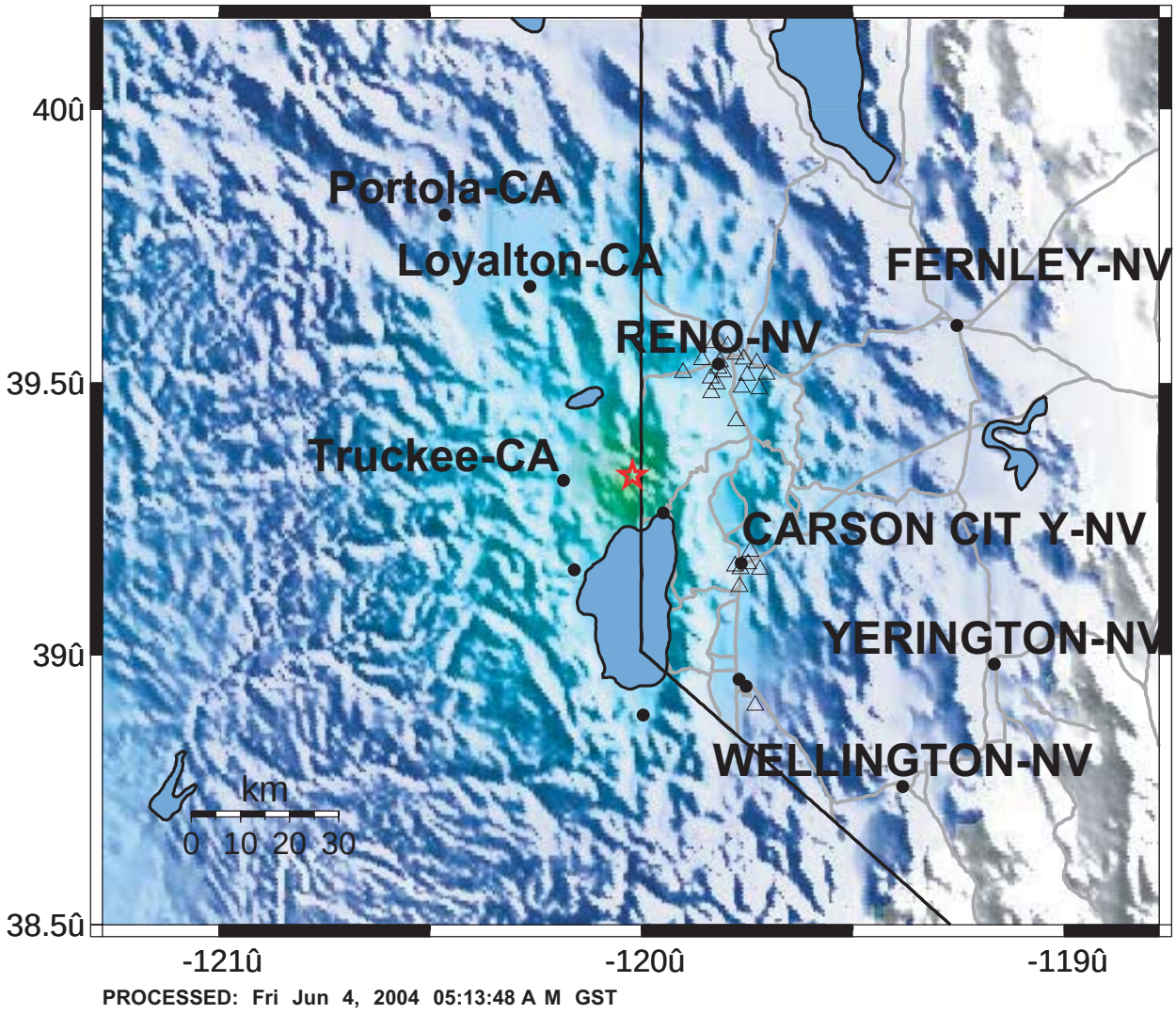


Figure 3. Magnitude 5.6 event and four M >4 aftershocks (solid blue) with smaller aftershocks (red dots). North-trending faults transfer strain eastward by normal and NE-striking relay faults.

UNR developed a low-power modem to facilitate PPP telemetry over Freewave uplinks and analog microwave. The system works reasonably well, but some debugging remains to be completed. This PPP-over-analog-microwave solution has the potential to give IP access to key spots within the network where standard IP solutions are not options and satellite communications would be expensive. One application being considered is to use it to add broadband stations in key spots in order to support a moment-tensor and moment-magnitude upgrade of network capabilities.

ShakeMap progress was good in the reporting year. UNR automated ShakeMap development some time ago, but as of the end of June 2004, ShakeMaps have been posted automatically to the NSL website. ShakeMaps are actually built on a separate machine so a flood of public queries cannot interrupt generation of the maps. ShakeMaps are developed for M 3.0 and larger events. The low threshold magnitude for making a ShakeMap ensures that the software and systems are exercised relatively often, but considering the location of most M 3 seismicity, most of these ShakeMaps have no constraining station contributions. For the present, the geologic grid layer for ShakeMaps uses an algorithm supplied with Antelope that scales shallow velocity from the local topographic slope. Forty-two strong-motion instruments, divided between Reno-Carson City and the Las Vegas Valley are presently installed and available



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC .(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Figure 4. Mercalli Intensity map for the June 3, 2004 M4.5 earthquake north of Lake Tahoe in eastern California. Shaking was felt in Reno, Carson City, and mountain communities of eastern California. This was the first event that included a significant number of ANSS-funded strong-motion stations.

(subject to telemetry issues noted earlier) to contribute to ShakeMap. The first substantial earthquake with strong-motion data under it was an M 4.5 event that occurred on June 3, 2004 (Figure 4). The Mercalli Intensity map deflects inward slightly around the strong-motion stations in the Reno and Carson City areas, indicating that either the "Small" regression relation in ShakeMap is not quite attenuating enough, or that the event under-performed compared to average for its magnitude. The ShakeMap of record for this event was produced by CISN, but constrained almost entirely by UNR data.

Progress was realized on another front through a cooperative effort with the Lawrence Livermore National Laboratory (LLNL). An LLNL mission made broadband stations in the Las Vegas Valley of interest to them. By sharing the mission and costs with ANSS, funding for the purchase and installation of four 6-channel broadband stations with strong-motion sensors became available. Equipment is either ordered or in hand, and installations are slated for winter 2004. The new stations should improve the earthquake detection threshold in the region and provide a more detailed view of basin amplification effects.

Also in the reporting period, UNR maintained data feeds to both southern and northern California CISN centers, to the University of Utah, and to NEIC. Earthquake information was provided to the public through QDDS and the NSL website. We installed code to check on QDDS after it was discovered "dead on its feet" - looking functional but not so. After the fact we learned from a CISN source that this is a known behavior for QDDS; perhaps it could have been avoided if system-level communications could be developed. Data from digital three-component stations are made available in real time through the IRIS DMC, including the BUD server. Outreach activities continued, including data exchange with the EQ educational network in Nevada.

Reports Published

Progress with ShakeMap was reported at the Basin and Range Province Seismic Hazard Summit II, held in May, 2004, in Sparks, Nevada. A publication entitled, "ShakeMap As A Tool For Understanding Seismic Hazard in Nevada" by Glenn Biasi and Kent Lindquist was accepted for publication by the Utah Geological Society in the conference proceedings volume.

Data Availability

Seismic recordings from the reporting year are archived at the Nevada Seismological Laboratory and available on request. Event excerpts are held in SAC format and on-line. Continuous data are archived in mini-SEED format to 4-mm tape, which because of the media, are more difficult to retrieve. Strong-motion station event excerpts are also available, although no true strong ground motions have been recorded. Data requests may be addressed to Glenn Biasi (775-784-4576, glenn@seismo.unr.edu) or Arturo Aburto (aburto@seismo.unr.edu).